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BULLETIN

OF THE

AMERICAN PHYSICAL SOCIETY

PROGRAMME OF THE

PASADENA MEETING

AT

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

December 16, 1944

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AMERICAN PHYSICAL SOCIETY

PASADENA MEETING, DECEMBER 16, 1944

THE 264th Meeting of the American Physical Society will be held at the California Institute of Technology, Pasadena, California, on Saturday, December 16, 1944. There will be two sessions, starting at 9:30 A.M. and 1:30 P.M. Both sessions will be held in Room 119, Kerckhoff Laboratory (north side of campus, near western end). The morning session will be devoted to a symposium on various aspects of the quantum theory, with invited papers by Paul S. Epstein, Hans Reichenbach, and Raymond T. Birge. The afternoon session will be devoted to contributed papers.

Luncheon will be served at the Athenaeum at noon, and it is requested that those from outside the campus, who expect to be present at the luncheon, notify Professor R. A. Millikan in advance of the meeting.

General Rules Relating to Papers

By vote of the Society on December 27, 1940, no paper may be accepted for presentation at any meeting of the Society unless the title and an abstract of the paper are delivered to the office of the American Physical Society not later than the closing date stated in the printed call for the meeting.

The time allowed for the oral presentation of a contributed paper is ten minutes at most.

When two or more papers are contributed by the same member, all but one are placed on the "supplementary programme." (A paper by two or more members is credited to the one first named in its title.) For each paper on this programme the Secretary indicates a session at which it may be presented. The presiding officer at this session may call for it when the other papers are completed, may require that it be given in shortened form, or may read it by title.

Titles and abstracts of the papers to be presented are given in the following pages. Proofs of these abstracts have not been submitted to the authors. After submission of proof the abstracts will be published in an early number of *The Physical Review*.

R. T. Birge,
Local Secretary for the Pacific Coast,
University of California
Berkeley, California

NOV 27 '44

PROGRAMME

Saturday Morning at 9:30 O'Clock

Room 119, Kerckhoff Laboratory

Invited Papers

The Conceptual Content of the Quantum Theory. Paul S. Epstein, *California Institute of Technology.* (50 min.)

The Logical Foundations of Quantum Mechanics. Hans Reichenbach, *University of California at Los Angeles.* (50 min.)

The 1944 Values of the Physical Constants of the Quantum Theory. Raymond T. Birge, *University of California.* (50 min.)

Saturday Afternoon at 1:30 O'Clock

Room 119, Kerckhoff Laboratory

Contributed Papers

1. A Possible Cause of the Variability with Time of the Incoming Cosmic Rays at High Latitudes. Robert A. Millikan, H. Victor Neher, and William H. Pickering, *California Institute of Technology.*—(1) We present new evidence that a new band of rays which we interpret as helium annihilation rays comes in vertically at about the predicted latitude. (2) We present a discussion of the possible composite character of the so-called silicon annihilation band and of the so-called oxygen annihilation band. (3) We bring forward an explanation of a possible cause of our observed variability in the incoming cosmic rays at high latitudes. (4) We make a new and more accurate determination of the value of the field sensitive and the non-field sensitive components of the incoming cosmic rays.

2. Some Recent Investigations on Hydrodynamic Stability. C. C. Lin, *Guggenheim Laboratory, California Institute of Technology* (Introduced by R. A. Millikan).—Recent investigations of the stability of two-dimensional parallel flows bring out that the physical mechanism underlying hydrodynamic stability in an incompressible fluid can be understood in terms of vorticity transfer.[1] In particular, the condition of vanishing curvature of the velocity profile in Rayleigh's criterion is identified with an extremum of vorticity distribution, and the physical picture describing the associated instability has been worked out in some detail. Conditions similar to Rayleigh's criterion have now been obtained for curved and axially symmetrical flows, and these can also be interpreted in a similar manner. Investigations of the stability in a compressible fluid are being carried out with the collaboration of L. Lees.

[1] Proc. Nat. Acad. Sci. (October, 1944).

3. Pressure Flow of a Turbulent Fluid between Two Parallel Infinite Planes. P. Y. Chou, *Guggenheim Laboratory, California Institute of Technology* (Introduced by R. A. Millikan).—This investigation is based upon a general theory developed by the author: "On velocity correlations and the solutions of the equations of turbulent fluctuation."[1] Two solutions of the problem are given. The first is the consequence of the equations of mean motion and of double correlation, while, in the second solution, all the equations of mean motion and of double and triple correlations are utilized. It is shown that the first solution holds good only in the central portion of the channel, while the second covers the entire channel except the immediate vicinity of the channel wall. The behavior of the mean squares of turbulent fluctuations is discussed qualitatively. The present calculation also indicates that the velocity defect $(U_c - U)/U_c$, which is independent of the Reynolds number of the mean flow, according to von Karman,[2] may also be independent of the magnitudes of the turbulent velocity fluctuation, after the flow has reached its steady turbulent state.

[1] To appear in the *Quarterly of Applied Mathematics* (April, 1945).
[2] Th. von Karman, Proc. Fourth Internat. Congress App. Mech. (1934), p. 69.

4. Frequency Elimination in Spirotron Systems for Accelerating Ions and Electrons. L. E. Dodd, *University of California at Los Angeles.*—The spirotron design changes

the speed of an electron or ion by components, with relatively low frequency of potential-reversal. It combines the cyclotron and magnetic-electron-microscope principles. Further modification eliminates frequency by using constant potential. This is getting back somewhat to former designs before the advent of the cyclotron. However, a difference is that here smaller diameter magnetic fields are permitted. Multiple electrode pairs, oppositely arranged on the surface of a cone, are replaced by a single pair of long straight electrodes, of the same general character as before, parallel to the magnetic field. The particle moves on the surfaces of a sequence of right-cylindrical helixes. These, with successive changes of radii, are joined together by a single straight line—the axis of the one electrode pair—parallel to the axes of all cylinders, but located in the surface of each, this common line and the cylinder axes being confined to the same plane. The particle travels a whole revolution between accelerations, instead of a half-revolution as in the cyclotron. Its path during this time is on one of the cylinders. Constant potential avoids frequency difficulties from relativistic change of mass at higher velocities.

5. Minimum Conditions Necessary to Achieve the Velocity of Escape. H. S. SEIFERT, *California Institute of Technology*.—The maximum velocity which may be achieved by a rocket directed vertically upward depends upon five basic parameters: (1) The velocity (relative to the rocket) with which mass is ejected; (2) the fraction of the total mass which is finally ejected, or "loading factor;" (3) the initial acceleration; (4) the dependence of acceleration upon time (flight law); (5) the dependence of frictional resistance upon time and velocity. The flight laws of constant acceleration and constant thrust have been considered. Although constant thrust produces higher terminal velocities than constant acceleration, the terminal accelerations produced in an efficient rocket by constant thrust are greater than a human passenger could tolerate. Assuming an initial acceleration of g, an energy loss due to friction equal to the kinetic energy of escape, constant thrust, and a step rocket consisting of three parts of mass ratios 16:4:1, each with a loading factor of 0.9, the attainment of escape velocity would require an ejection velocity over 3000 meters per second.

6. The Relativistic Increase in Ionization of Cosmic-Ray Electrons. WAYNE E. HAZEN, *University of California*.—The preliminary experiments of Corson and Brode[1] have been continued with improved techniques and a stronger magnetic field (4500 gauss). It is believed that uncertainties in condensation efficiency and curvature no longer contribute significantly to the errors. The overlapping of drop images and its variation with track diffuseness probably limit the accuracy of both absolute and comparative ionizations to 10 percent. The minimum ionization, which was obtained from 35 tracks of P^{32} beta-rays with $H\rho > 4500$, is 40 ion pairs per cm in air at N.T.P. The average ionization of 15 cosmic-ray electrons with $H\rho$ of $1\text{–}8\times10^6$ is 53. These figures for ionization are for the ionization produced as a result of all collisions in which the primary electron loses less than ~ 600 ev. Theory predicts an increase of 40 percent, which agrees with the experimental results within the estimated uncertainty.

[1] D. R. Corson and R. B. Brode, Phys. Rev. **53**, 773 (1938).

7. The Diffusion Problem and the Theory of Connected Events. DONALD A. DARLING, *California Institute of Technology* (Introduced by R. A. Millikan).—An extension of the one-dimensional random walk to the case where the particles possess inertia leads to a statistical problem in the theory of non-independent, or Markoff, processes. The modification of the "homogeneous random process" in this case is deduced, and the meaning to be attached to random events extended to the continuum is studied. The analogue to the ordinary diffusion equation becomes an integro-differential equation

$$\frac{\partial p(t, x)}{\partial t} = \kappa \frac{\partial^2 p(t, x)}{\partial x^2} \int_0^\infty \Phi(t, y) y^2 dy,$$

where $p(t, x)$ is the probability that the particle (possessing inertia) has a displacement x at a time t, and $\Phi(t, y)$ is a solution to the ordinary diffusion equation. Solutions of the equation are deduced by considering the moments of the probability distribution. Some of the equations used in turbulence and Brownian movement problems are special cases of the integro-differential equation, with a suitable interpretation of the dependence function Φ.

8. Magnesium Ion Source for High Intensity Mass Spectrograph. T. H. PI, *California Institute of Technology* (Introduced by R. A. Millikan).—Magnesium ions were produced by bombarding magnesium vapor by electrons emitted from oxide-coated cathodes. The ions were then focused into a thin sheet by means of an electrostatic lens. This ion sheet was sent into the magnetic lens, which focused the sheet into a small spot where the different isotopes were collected. The ion current obtained at the collector was 120 microamperes with good resolution.

9. The Movement of Bed Particles in a Turbulent Stream. HANS ALBERT EINSTEIN, *California Institute of Technology* (Introduced by R. A. Millikan).—The current theory of suspensions in turbulent streams uses an equilibrium condition between the continuous settling of the particles in the surrounding water and the vertical turbulent exchange of water masses to establish the law for the vertical distribution of sediment concentration. At the bed itself this argument breaks down because here the exchange of liquid approaches zero. However, an exchange of particles between the bed and the moving layers exists, and like all such acts of exchange, is governed by the general rules of probability. The probability of a particle moving out of its position in the bed can be related directly to the probability of the adjoining liquid having a certain velocity. If one introduces the measured probabilities for instantaneous velocities near the bed, the law for the movement of particles out of the bed can be predicted up to some general constants. The law obtained describes very closely

the sediment movement in laboratory flumes and natural rivers.

10. The Rydberg Constants and the Value of e/m. CHAO-WANG HSUEH, *California Institute of Technology.*—The wave-lengths of the H-alpha and D-alpha lines were measured with a Fabry-Perot interferometer directly against the primary standard of wave-length, 6438.4696IA. The results of the measurements are: 6562.85337±0.00022IA for H-alpha, and 6561.06811±0.00005IA for D-alpha. Following William's assignment,[1] they are the respective wave-lengths of the strong component-group (145). From the above values, the Rydberg constant for hydrogen R_H, for deuterium R_D, for helium R_{He}, and for infinite mass R_∞, and also the values of e/m and E, the atomic weight of electron, were calculated. They are as follows:

$$R_H = 109{,}677.5795 \pm 0.0037 \text{ cm}^{-1},$$
$$R_D = 109{,}707.4226 \pm 0.0008 \text{ cm}^{-1},$$
$$R_{He} = 109{,}722.2694 \pm 0.0024 \text{ cm}^{-1},$$
$$R_\infty = 109{,}737.3111 \pm 0.0041 \text{ cm}^{-1},$$
$$e/m = (1.75883 \pm 0.00022) \times 10^7 \text{e.m.u./g},$$
$$E = (5.48740 \pm 0.00069) \times 10^{-4}.$$

For convenience, the result for E is also expressed in the following ways: $1/E = 1822.36 \pm 0.23$, number of electrons per unit atomic weight; $H/E = 1837.17 \pm 0.24$, ratio of mass of hydrogen atom to that of electron.

[1] R. C. Williams, Phys. Rev. **54**, 559 (1938).

SUPPLEMENTARY PROGRAMME

11. The Turbulent Jet. P. Y. CHOU, *Guggenheim Laboratory, California Institute of Technology* (Introduced by R. A. Millikan).—The first solution of the jet problem based upon the equations of turbulent fluctuation was given by C. C. Lin,[1] who derived the so-called constant "exchange coefficient" from the equations of mean motion and of double correlations by using the values of the triple correlations at the center of the jet. The agreement between theory and experiment of the velocity and temperature distributions for the plane and axial jets is satisfactory. This constant exchange coefficient has been assumed recently by Görtler, based upon physical arguments.[2] Since 1941 the general theory of turbulence has been improved and the jet problem has again been attacked by S. S. Huang,[3] and the solution agrees with Lin's result for the plane and axial jets and with Tollmien's for the half-jet under the momentum transport theory. According to the latest version of the general theory, the constant exchange coefficient still follows as a first approximation from the equations of mean motion and of double correlations, substantiating Lin and Huang's results. It is also shown that these equations provide a basis for the more accurate solutions to the problem.

[1] Science Report of National Tsing Hua University, 1941.
[2] Zeits. f. angew. Math. u. Mech. **22**, 244 (1942).
[3] S. S. Huang, master's thesis, National Tsing Hua University, 1943.

12. Radio Direction Finding at a Wave-Length of 1.8 Meters. W. H. PICKERING, J. DAVID, AND W. F. HORNYAK, *California Institute of Technology.*—The accuracy attainable with an Adcock type antenna has been investigated. Particular attention has been directed to bearing errors due to polarization of the transmitted wave and to nearby objects behaving as parasitic radiators. The antenna consisted of two vertical quarter-wave rods spaced three-quarters of a wave-length. The effects of various types of grounding plane have also been investigated. With favorable conditions an accuracy of 0.2 degree is attainable, but polarization errors may be as large as 10 degrees. For best determination of the null direction, the receiver output is recorded on a paper strip synchronized with the rotation of the antenna.